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Agronomic Characteristics and Disease Resistance of Winter Barleys Tested in Missouri, 1943 to 1948

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Agronomic Characteristics and Disease Resistance of Winter Barleys Tested in Missouri, 1943 to 1948

J. M. Poehlman[1]

INTRODUCTION

Observations on the agronomic characteristics and disease resistance of 249 varieties and strains of winter barley grown at Columbia, Missouri, during the years 1943 to 1948 are reported in this bulletin.

Varieties and strains with superior qualities are the building materials used by the plant breeder; from them are fashioned the improved varieties of tomorrow. Thus an important step in developing a breeding program with any crop is to survey the varieties and strains available and search out those which, because they possess one or more outstanding characteristics, may be useful as parent material.

There is less known about sources of resistant and superior breeding material in winter barley than in the other small grains such as wheat and oats, or even in the spring barleys. The winter barley crop is not grown as extensively and its improvement has been less vigorously pursued. In the past there has been a tendency to look toward the spring barleys for sources of breeding material, especially disease resistance. Usually selections from such crosses are less hardy than the winter parent. In the northern part of the winter barley area, where it is necessary to improve the winter hardiness of the barley plant to make it a safer crop, it appears that hardiness could be more completely retained, and perhaps more easily increased, if sources of desirable characteristics, including disease resistance, could be found in winter types with moderate to good hardiness.

With this view of the winter barley breeding problem, an attempt has

[1]Acknowledgment is made to Mr. C. K. Cloninger, Instructor in Field Crops, for assistance in making the smut inoculations in 1947 and 1948; to Mr. Wm. P. Sappenfield and Mr. Lloyd E. Cavanah, Assistant Instructors in Field Crops, for assistance with the field work in 1948; to Dr. G. A. Wiebe, Principal Agronomist, Division Cereal Crops and Diseases, for supplying seed of varieties and strains of barley received through the uniform nurseries and the world collection; to Dr. V. F. Tapke, Pathologist, Division Cereal Crops and Diseases, for supplying races of *U. nigra* loose smut and covered smut; and Mr. John B. Combs, Supervisor, University of Missouri I B M Tabulating Section, for assistance in tabulation of the data.

been made at the Missouri Agricultural Experiment Station to grow available winter hardy types over a period of several years, and to study their agronomic characteristics and disease resistance. Observations, for the years 1943 to 1948, on winter survival, maturity, height, lodging, and reaction to mildew, *U. nuda* loose smut, *U. nigra* loose smut, covered smut, and scald are summarized in this bulletin.

These results are not offered as final or positive evidence of hardiness or disease resistance. Demonstration of susceptibility to disease may be simple, but demonstration of resistance is a long and continuing process. As every experienced agronomist knows, results may be affected by soil and seasonal conditions, disease inoculation techniques, races of the disease organism causing natural epidemics or used in artificial inoculations, and many other causes. Observations made here are, therefore, offered as an accumulation of agronomic and disease notes, laboriously obtained, carefully recorded, painstakingly tabulated and analyzed. If they are used to identify sources of superior breeding material and prevent duplication in testing of strains in which susceptibility to disease has already been clearly demonstrated, they will serve their purpose. Such complete information about these winter barleys has not been available heretofore.

VARIETIES AND STRAINS STUDIED

The 249 varieties and strains studied were obtained from commercial seedsmen, agricultural experiment stations, and the U. S. Department of Agriculture. From the source last named, the Division of Cereal Crops and Diseases supplied their uniform hardiness, yield, disease and classification nurseries. Observations on 177 strains from the world collection of the Department are included in this report.

For convenience in organizing the data, these varieties and strains have been divided into six groups more or less according to origin and commercial use and will be described and reviewed in that order. The first five groups include mostly varieties and strains that have been grown commercially or that have been tested in one or more of the uniform nurseries and are generally well known to winter barley breeders. The sixth group includes the strains from the world collection and have been less extensively tested in breeding nurseries.

1. **Rough-awned, Tennessee Winter Types.**—This group includes 23 varieties and strains, 16 of which have been described by Aberg and Wiebe (1)* as similar to the Tennessee Winter type variety. They are Scottish Pearl, Michigan Winter, Wisconsin Winter, Ward, Reno, Woodwin, Ohio 1, Purdue 21, Tennessee Winter, Tennessee Winter 52, Kentucky 1, and Kentucky 2. Seven additional strains, Admire, Kansas South East, Kirwin, Kentucky 6, Kentucky 36, Ludwig, and Purdue 1101 Selection conform closely with this group. In-

*Number in parenthesis refers to literature cited (page 26).

clusion of Brier, Wintex and Randolph with the Tennessee Winter types might be questioned since they are less hardy but they have some characteristics in common with the Tennessee Winter barleys and are therefore placed here for convenience. Tenkow is of hybrid origin but has a Tennessee Winter type variety as a parent and is thus included here.

2. Smooth-awned Varieties of Tennessee Winter Type Origin.—This group contains eight smooth-awned varieties and strains which have originated from crosses between smooth-awned spring varieties and Tennessee Winter type varieties. Marnobarb, Smooth awn 86, Smooth awn 88, Jackson and Jackson 1 were described by Aberg and Wiebe (1). Kentucky 11 and the two Purdue Smooth awn strains are experimental selections obtained in uniform nurseries.

3. Introduction and Miscellaneous.—In this group are ten varieties varying somewhat in awn characteristics, but all are introduced or probably derived from introduced barleys. Poland, Bulgarian, Olympia, Wong and Awnless are described by Aberg and Wiebe (1) as introduced varieties, Sunrise and possibly Marett Awnless as selections from introductions, and Calhoun as a hybrid with two introduced varieties as parents. The origin of Winter Club and Marett Awnless is unknown. Alaska has been classified as an introduction although similar in many respects to the rough-awned Tennessee Winter types. This group is separated from the introductions in Group 6, since all of these varieties have been grown commercially in the United States, or have been extensively tested in uniform nurseries. Poland, Bulgarian, Olympia, Alaska, and Winter Club are rough-awned varieties; Wong, Calhoun and Sunrise have short awns, especially on the lateral florets; Awnless and Marett Awnless are awnless varieties.

4. Selections From Composite Crosses.—This group includes four varieties and one experimental selection originating from composite crosses as described by Harlan and Martina (4). One variety of this group, Nassau, is smooth-awned; the others, Santiam, Davidson, Okla. Sel. 1-35-216, and Cascade are rough-awned. All were described by Aberg and Wiebe (1) except Okla. Sel. 1-35-216. It was obtained in a uniform yield nursery.

5. Hooded Winter Varieties and Selections. — Thirty hooded varieties and selections are included in this group. The origin of many of these can be traced directly, or indirectly, to one of the Tennessee beardless types, which originated from a cross made by Mooers (6) between Tennessee Winter and a spring beardless type. Tennessee Beardless 6 (CI 2746)*, Tennessee Beardless 5, Missouri Early Beardless, Iredell, Hooded 16, Huga, North Carolina Hooded 26, Tucker, and Marett Hooded 4 were described by Aberg and Wiebe (1). They also list York Hooded as a synonym of Tennessee Beardless 6 (CI 2746), and Brugh 76 as a synonym of Tennesse Beardless 5. The additional selections reported here, Tennessee Beardless 6 (CI 3385), North Carolina

*CI number refers to accession number of the Division of Cereal Crops and Diseases, U. S. Department of Agriculture.

Hooded (CI 5951), Woods Hooded, Brugh 23, Hooded 10, and Clemson Hooded, were received in the uniform nurseries.

Three of the hooded strains reported here are selections from Kinroku. Kinroku (CI 5265) is a bearded winter type of foreign origin and was sent to the Missouri Agricultural Experiment Station in the fall of 1940 along with other introductions by the Division of Cereal Crops and Diseases. Several hooded plants were later selected from a row of Kinroku. Because of their similarity to the hooded strains of Tennessee Beardless origin, the question is raised as to whether they may not have originated as the result of a natural cross with a hooded winter variety, probably Missouri Early Beardless.

Ten strains included here are pure line selections made at the Missouri Agricultural Experiment Station from Missouri Early Beardless. The exact origin of Missouri Early Beardless is unknown, but these selections have certain characteristics in common with the Tennessee beardless types and may be of similar origin.

6. **Hardy Strains From U. S. D. A. World Collection.** — This group contains 177 varieties and strains. In the fall of 1942, 708 winter types from the U. S. Department of Agriculture world collection were sent to the Missouri Agricultural Experiment Station from the Division of Cereal Crops and Diseases. During the winter of 1942-43 winter injury at Columbia was sufficiently severe that the more hardy strains could be sorted out for additional testing. Observations have now been made on 177 of these strains over the six-year period, 1943 to 1948. The name, source, origin and description of each variety, together with notes on type of plant growth, heading date, winter survival, and mildew and leaf rust reaction at several experiment stations in the 1943 season were compiled and published as a mimeographed report by Wiebe (14). Additional observations on winter hardiness and disease resistance, especially reaction to the smuts, mildew and scald, are presented here.

YEARS GROWN

Varieties and strains in the first five groups were grown during the five-year period 1944 to 1948. In 1944 and 1945 these varieties were scattered in several nurseries. In 1946, 1947 and 1948 a single 16-foot row of each variety was grown in a single variety nursery for comparison of winter killing, date of heading, height and disease reaction insofar as the latter could be obtained from natural infections. The 177 strains from the world collection were grown during the six-year period, 1943 to 1948, inclusive. These were also grown in single 16-foot rows, with check rows of Missouri Early Beardless and Reno spaced at regular intervals. Since the data for this latter group of varieties covers one additional season, the averages of the two check varieties are also included so that comparisons may be made with varieties in the first five groups.

All varieties were not grown in every year. Exceptions are as follows: Tennessee Winter 52 and Okla. 1-35-216, grown in one season only; Brier,

Cascade, Ludwig, Purdue 1101 Sel., and Awnless, grown in two seasons; Poland and Santiam, grown in three seasons; and Olympia, Marett Awnless, Winter Club, Tennessee Beardless 6 (CI 2746), Hooded 10, and York Hooded grown in four seasons.

SOIL AND SEASONAL CONDITIONS AT COLUMBIA, MISSOURI, 1943 TO 1948

Varieties and strains studied here were grown each year on the University of Missouri South Farms, located four miles Southeast of Columbia. The soil type is classified as Putnam silt loam and is characterized by a heavy claypan layer 6 to 8 inches below the surface. This results in the soil drying out slowly in the spring, a condition unfavorable to good barley culture. On the plots where these barleys were grown, fertility has been maintained at a high level by using a rotation in which lespedeza is plowed under each year and by additions of 200-350 pounds of commercial fertilizer annually. Soil pH has been adjusted by adding commercial limestone.

TABLE 1--MONTHLY PRECIPITATION AND MONTHLY MEAN TEMPERATURES AT COLUMBIA, MISSOURI, FOR THE MONTHS OF SEPTEMBER TO JUNE INCLUSIVE DURING THE SIX CROP SEASONS, 1943 TO 1948.

Crop Season	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total or Mean.
	MONTHLY PRECIPITATION IN INCHES										
1942-43	4.57	1.43	3.41	4.51	0.88	0.79	1.76	2.16	13.34	8.02	40.87
1943-44	4.84	3.85	1.52	2.17	0.47	2.78	3.81	9.53	4.02	0.83	33.82
1944-45	5.67	1.14	1.83	1.58	0.94	2.50	6.04	6.36	5.80	9.50	41.36
1945-46	13.34	1.60	0.30	1.44	2.43	2.14	2.41	3.00	6.34	2.23	35.23
1946-47	1.57	5.85	5.09	1.42	0.96	0.23	3.93	6.45	3.24	7.02	35.76
1947-48	3.34	3.07	1.65	1.99	1.15	2.04	3.72	0.82	3.71	6.71	28.20
Normal	4.35	2.61	2.20	1.86	1.92	2.04	2.94	3.77	4.46	4.76	30.91
	MONTHLY MEAN TEMPERATURES IN DEGREES FAHRENHEIT										
1942-43	67.6	57.7	47.6	31.3	29.3	38.4	39.0	55.0	63.0	75.8	50.5
1943-44	65.4	56.3	41.6	29.4	34.9	36.3	40.4	51.1	69.2	77.6	50.2
1944-45	68.8	59.4	46.1	27.2	28.2	34.1	52.4	55.0	59.6	69.1	50.0
1945-46	69.0	56.4	45.9	26.4	32.8	40.2	56.0	59.5	61.4	74.6	52.2
1946-47	68.9	62.0	46.8	39.0	34.4	28.3	36.4	54.0	62.0	72.8	50.5
1947-48	72.8	66.2	41.0	38.5	25.0	32.6	41.8	61.0	64.2	73.7	51.7
Normal	69.4	56.9	44.1	34.0	30.9	32.5	42.9	54.8	65.0	73.4	50.4

Data from official records of the U. S. Weather Bureau, Columbia, Missouri.

The latitude of Columbia is approximately 39° N., which is about that of Kansas City, Missouri; Cincinnati, Ohio; and Washington, D. C. It is at the extreme northern edge of the area in Missouri where even the more hardy winter barley varieties may be grown without losses from winter killing. Snow cover is uncertain and the barley crop is sometimes subjected to killing temperatures without protection. Winter barley nurseries are planted about mid-September and good fall growth is obtained. In the spring, excessive rainfall

during March, April and May will result in the soil remaining water-logged for long periods, a condition conducive to heaving during early spring as well as to poor aeration and root development as long as this condition exists.

Monthly precipitation and monthly mean temperature for the ten-month period, September to June, inclusive, during the six years that this study covers, are reported in Table 1.

The minimum temperatures recorded by the U. S. Weather Bureau at Columbia for the months December through March for the years covered by the six crop seasons, 1943 to 1948, are reported in Table 2. In the first part of the table, the depth of the snow cover at the time of minimum temperature is shown by the superscript. Since snow cover will reduce the cold injury, the minimum temperatures recorded without more than a trace of snow are also shown. It will be observed that at no time during the six-year period covered by this study did the temperature go below zero degrees Fahrenheit, without the benefit of snow cover. This was in general a cycle of years in which winter injury to barley and other winter grains such as wheat and rye was never extremely severe.

TABLE 2--MINIMUM TEMPERATURES, RECORDED WITH AND WITHOUT SNOW COVER, AT COLUMBIA, MISSOURI DURING THE SIX CROP SEASONS, 1943-'48.

	Minimum temperature in degrees Fahrenheit and inches snow cover on same date				Minimum temperature in degrees Fahrenheit without snow cover in excess of a trace			
	Dec.	Jan.	Feb.	Mar.	Dec.	Jan.	Feb.	Mar.
1942-43	6^{T*}	-12^{3}	3^{T}	0^{2}	6^{T}	1	3^{T}	2
1943-44	-9^{4}	8^{T}	-5^{2}	17	4	8^{T}	10	17
1944-45	3^{1}	0^{T}	6^{7}	14	10	0^{T}	7	14
1945-46	-3^{9}	6^{T}	8^{4}	23	11	6^{T}	20	23
1946-47	4^{T}	-6^{6}	5^{T}	9^{T}	4^{T}	9	5^{T}	9^{T}
1947-48	16	-9^{2}	3^{T}	-4^{2}	16	2	3^{T}	19

* Superscript represents inches of snow cover (T = trace).
Data from official records of U. S. Weather Bureau, Columbia, Missouri.

PRESENTATION OF DATA

Observations in this bulletin cover per cent winter survival, date of heading, height, lodging, and reaction to mildew, *U. nuda* loose smut, *U. nigra* loose smut, covered smut and scald. Handling of the data was facilitated by the use of I B M punch cards. Yearly records of varietal performance are not reported here because a large number of observations were involved; but the average performance of each variety for the years in which observations were made is reported in Table 3. Weighted averages for survival, date of heading, height and lodging are used for varieties not grown every year. These averages are based on the performance of the variety in the years grown in relation to the average performance of the rough-awned Tennessee Winter type varieties. The source or origin and the varietal descriptions of the varieties from the world

TABLE 3--AGRONOMIC NOTES AND DISEASE RESISTANCE OF BARLEY VARIETIES GROWN IN MISSOURI, 1943-1948

Number	Variety	Source or origin	Description	Survival %	Date headed	Height inches	Lodging %	Mildew fall	Mildew spring	U. nuda %	U. nigra heads/row	U. hordei heads/row	Scald
1. Rough awned varieties of Tennessee Winter type or similar origin													
CI* 277	Scottish Pearl	----------	-------	88	5/13	33	55	5	5	16.8	15	10	1
CI 646	Tenkow	----------	-------	42	5/17	28	52	5	5	30.3	1	0	5
CI 2036	Michigan Winter	----------	-------	87	5/13	33	54	5	5	28.4	14	4	2
CI 2159	Wisconsin Winter	----------	-------	79	5/13	31	55	5	5	49.6	13	4	1
CI 3543	Tennessee Winter 52	----------	-------	82	5/12	33	57	-	5	---	58	12	-
CI 4581	Purdue 21	----------	-------	86	5/19	40	40	-	4	41.2	13	5	4
CI 4677	Kentucky 36	----------	-------	85	5/14	35	50	4	3	27.7	3	1	1
CI 4678	Kentucky 6	----------	-------	86	5/13	35	43	5	5	16.5	10	8	1
CI 6007	Ward	----------	-------	87	5/14	33	57	5	5	32.0	20	9	2
CI 6034	Tennessee Winter	----------	-------	82	5/16	32	60	5	5	23.5	7	1	5
CI 6050	Kentucky 1	----------	-------	90	5/17	40	42	4	1	5.4	9	2	2
CI 6127	Wintex	----------	-------	51	5/17	38	52	5	5	38.2	5	1	5
CI 6148	Kentucky 2	----------	-------	86	5/12	39	45	4	3	11.9	8	5	2
CI 6372	Randolph	----------	-------	67	5/09	33	68	5	5	24.5	13	0	2
CI 6377	Admire	----------	-------	90	5/14	34	54	5	5	30.0	7	4	1
CI 6561	Reno	----------	-------	89	5/13	33	56	5	5	47.7	16	15	2
CI 7033	Woodwin	----------	-------	86	5/14	35	54	5	5	45.0	13	4	2
CI 7070	Kansas Southeast	----------	-------	90	5/14	34	46	5	5	---	22	5	1
CI 7072	Ohio 1	----------	-------	82	5/14	35	55	5	5	35.4	17	8	2
CI 7075	Kirwin	----------	-------	88	5/13	33	63	5	5	21.6	12	6	1
CI 7157	Brier	----------	-------	82	5/08	32	57	4	2	67.7	4	0	1
CI 7523	Purdue 1101 Sel.	----------	-------	91	5/28	40	28	5	4	62.1	6	5	1
CI 7525	Ludwig	----------	-------	92	5/15	30	76	4	5	65.9	2	0	4
2. Smooth awned varieties of Tennessee Winter type origin													
CI 6021	Kentucky 11	----------	-------	78	5/12	36	35	4	3	49.5	13	5	5
CI 6120	Marnobarb	----------	-------	57	5/09	33	42	5	4	37.8	6	2	5
CI 6268	Smooth Awn 86	----------	-------	61	5/10	34	48	5	4	52.3	21	2	5
CI 6569	Jackson	----------	-------	74	5/15	34	50	5	3	26.3	15	0	3
CI 7028	Smooth Awn 88	----------	-------	64	5/12	32	62	5	4	---	16	9	5
CI 7045	Jackson 1	----------	-------	76	5/14	33	34	5	5	58.1	19	2	5
CI 7067	Purdue Smooth Awn	----------	-------	81	5/18	35	40	4	4	72.7	14	6	5
CI 7119	Purdue Smooth Awn	----------	-------	79	5/18	31	48	5	4	41.1	15	4	5
3. Introductions and Miscellaneous													
CI 521	Bulgarian	----------	-------	69	5/30	36	44	5	3	---	8	10	5
CI 534	Alaska	----------	-------	85	5/14	33	35	5	4	32.8	3	0	1
CI 592	Winter Club	----------	-------	80	6/12	34	20	1	3	---	--	--	5
CI 5029	Awnless	----------	-------	52	5/12	27	69	-	1	---	--	--	5
CI 6107	Olympia	----------	-------	69	5/29	37	46	5	4	36.9	8	2	2
CI 6272	Sunrise	----------	-------	67	5/12	31	63	2	1	24.3	5	5	5
CI 6280	Poland	----------	-------	84	5/15	32	45	3	2	44.0	24	10	2
CI 6728	Wong	----------	-------	76	5/16	33	48	4	1	11.6	8	3	5

TABLE 3--AGRONOMIC NOTES AND DISEASE RESISTANCE OF BARLEY VARIETIES GROWN IN MISSOURI, 1943-1948 (CONT'D)

Number	Variety	Source or origin	Description	Survival %	Date headed	Height inches	Lodging %	Mildew fall	Mildew spring	U. nuda %	U. nigra heads/row	U. hordei heads/row	Scald
CI 7073	Marett Awnless	----------	-------	33	5/12	28	76	1	1	---	--	--	5
CI 7120	Calhoun	----------	-------	69	5/11	29	47	3	1	---	6	2	5
4. Selections from composite crosses													
CI 6367	Santiam	----------	-------	78	5/14	32	45	5	5	12.5	13	8	-
CI 6373	Davidson	----------	-------	77	5/08	33	60	5	5	26.1	14	--	-
CI 7022	Nassau	----------	-------	81	5/11	32	43	5	5	18.6	20	10	5
CI 7146	Cascade	----------	-------	26	5/18	34	35	5	5	---	3	1	-
CI 7524	Okla. 1 35 216	----------	-------	79	5/11	30	54	5	5	6.6	--	--	-
5. Hooded varieties of Tennessee Beardless or similar origin													
CI 2746	Tenn. Beardless 6	----------	-------	76	5/07	37	63	5	5	13.7	3	5	5
CI 3385	Tenn. Beardless 6	----------	-------	80	5/15	41	53	4	2	25.0	18	5	4
CI 3384	Tenn. Beardless 5	----------	-------	71	5/20	40	59	4	2	12.8	9	5	1
CI 5951	N. C. Hooded	----------	-------	78	5/10	38	63	5	5	6.8	5	4	5
CI 6051	Mo. E. Beardless	----------	-------	82	5/09	35	79	5	5	16.0	10	5	5
CI 6235	Woods Hooded	----------	-------	79	5/18	36	65	5	5	1.5	5	5	5
CI 6477	Brugh 76	----------	-------	70	5/19	36	60	5	5	1.1	4	5	4
CI 6491	Brugh 23	----------	-------	81	5/10	35	69	5	5	.4	1	3	5
CI 6563	Hooded 10	----------	-------	75	5/17	35	60	5	5	2.3	5	5	-
CI 6571	Iredell	----------	-------	77	5/13	38	50	5	3	0	1	5	5
CI 6574	Hooded 16	----------	-------	77	5/12	36	78	5	4	4.6	0	1	5
CI 6998	Huga	----------	-------	73	5/10	35	63	5	5	0	2	2	5
CI 7026	N. C. Hooded 26	----------	-------	76	5/12	36	60	5	3	0	10	4	5
CI 7038	York Hooded	----------	-------	77	5/21	36	65	5	4	0	10	9	5
CI 7039	Tucker	----------	-------	83	5/11	36	70	2	1	17.5	3	2	5
CI 7042	Clemson Hooded	----------	-------	69	5/09	35	78	5	5	2.8	5	3	5
CI 7074	Marett Hooded 4	----------	-------	73	5/09	35	75	5	5	0	13	15	5
B** 467	Sel. Kinroku	----------	-------	75	5/07	32	44	-	5	1.2	0	0	5
B 468	Sel. Kinroku	----------	-------	81	5/07	32	40	-	5	4.6	2	1	5
B 659	Sel. Kinroku	----------	-------	82	5/07	36	45	-	5	2.8	0	2	5
B 351	Sel. Mo. E. Beardless	----------	-------	78	5/11	37	40	2	2	.9	2	2	5
B 355	Sel. Mo. E. Beardless	----------	-------	81	5/18	39	30	2	1	37.5	6	1	5
B 404	Sel. Mo. E. Beardless	----------	-------	82	5/06	34	75	5	5	1.4	25	11	5
B 411	Sel. Mo. E. Beardless	----------	-------	77	5/07	35	60	5	5	.2	0	2	5
B 472	Sel. Mo. E. Beardless	----------	-------	76	5/10	36	68	4	3	0	1	1	5
B 495	Sel. Mo. E. Beardless	----------	-------	78	5/17	37	28	1	1	37.6	23	14	2
B 502	Sel. Mo. E. Beardless	----------	-------	79	5/08	33	88	5	5	.2	1	1	5
B 507	Sel. Mo. E. Beardless	----------	-------	76	5/09	35	72	5	5	0	1	2	5
B 538	Sel. Mo. E. Beardless	----------	-------	78	5/09	33	49	5	5	0	0	3	5
B 539	Sel. Mo. E. Beardless	----------	-------	78	5/08	32	62	5	5	2.5	1	1	5
6. World collection													
CI 170	Mensury	Manchuria	6B RHS	89	5/12	32	40	5	5	24.8	13	7	1

TABLE 3--AGRONOMIC NOTES AND DISEASE RESISTANCE OF BARLEY VARIETIES GROWN IN MISSOURI, 1943-1948 (CONT'D)

Number	Variety	Source or origin	Description	Survival %	Date headed	Height inches	Lodging %	Mildew		U. nuda	U. nigra	U. hordei	Scald
								fall	spring	%	heads/row	heads/row	
CI 206	Han River	China	6B RHS	84	5/11	31	50	5	5	3.4	36	20	1
CI 257	Tennessee Winter	Europe	6B RHS	87	5/12	31	61	5	5	21.7	10	4	1
CI 554	Texas Winter	Europe	6B RHS	75	5/12	31	47	5	5	49.6	30	10	2
CI 704	Popeline	Caucasus	6BKRHS	72	5/17	31	35	1	1	55.5	1	1	2
CI 736	Venus	China	6B RHL	71	5/09	30	68	1	2	55.5	4	1	4
CI 737	Niver	China	6B RHL	70	5/08	33	63	1	1	75.0	1	1	3
CI 741	Nu Er Ta	China	6B HHL	83	5/09	31	75	3	1	25.1	2	2	5
CI 742	Rice	China	6W RNL	75	5/10	28	63	4	1	7.6	3	3	5
CI 868	Taihu	China	6W RNL	61	5/10	29	78	4	1	11.1	1	4	5
CI 876	Tennessee Winter	Europe	6W RHS	88	5/11	33	45	5	4	53.6	19	16	1
CI 895	Cusada	Hybrid	6W RHS	91	5/12	34	30	5	4	45.8	15	8	1
CI 896	Arabel	Hybrid	6B RHS	88	5/11	33	50	5	5	32.7	17	6	1
CI 898	Omar	Hybrid	2B RHS	85	5/12	35	43	5	5	4.4	9	5	4
CI 901	Pidor	Hybrid	6B RHL	81	5/11	35	50	1	2	32.5	1	1	4
CI 1002	Clancy	Russia	6W RHL	80	5/16	38	48	2	5	1.0	10	2	2
CI 1063	Koran	China	6B RHL	64	5/10	36	53	1	1	20.6	1	1	5
CI 1065	Kunshan	China	6B RHL	71	5/08	31	50	4	1	17.0	1	1	4
CI 1089	Gehangir	China	6B RHL	60	5/18	31	58	1	4	---	21	1	5
CI 1107	Cartouch	Switzerland	6B RHS	80	5/11	32	60	5	5	40.0	17	11	1
CI 1108	Carytid	Switzerland	6B RHL	78	5/20	36	20	4	5	22.6	11	4	2
CI 1117	Khayyam	Hybrid	2B RHS	86	5/13	35	30	5	5	16.5	3	2	5
CI 1222	Abyssinian	Abyssinia	6BKRHS	74	5/19	34	38	1	3	13.8	11	1	5
CI 1230	Abyssinian	Abyssinia	6BKRHS	68	5/20	35	43	2	1	18.9	7	1	5
CI 1231	Abyssinian	Abyssinia	6B RHS	77	5/19	33	41	2	1	56.8	2	0	2
CI 1264	Donjon	Mexico	6BKRHS	73	5/19	34	44	1	1	55.8	2	1	5
CI 1266	Sabbaton	China	6B RHL	82	5/08	31	70	1	1	19.6	1	1	5
CI 1412	Abundio	Persia	6W RHL	79	5/20	28	70	2	2	0	1	1	2
CI 2033	Ohio Winter	Ohio	6B RHS	85	5/13	34	46	-	3	27.3	2	1	1
CI 2202	Black Russia	Tiflis	6BKRHS	78	5/19	36	49	1	1	23.8	1	0	3
CI 2324	Horsford	China	6B HHL	79	5/09	32	70	4	3	14.5	1	1	2
CI 2350	----------	Tiflis	6BKRHS	75	5/19	34	36	1	3	20.4	1	0	3
CI 2420	----------	----------	6B RHL	83	5/12	36	41	5	5	39.5	9	6	1
CI 2428	Poree	Japan	6W RNL	79	5/11	14	40	4	4	10.9	4	4	5
CI 2460	Lochink	China	6B RHL	70	5/12	14	30	1	1	16.6	2	2	2
CI 2473	Nunca	China	6W RHL	72	5/08	32	68	1	1	6.7	1	1	4
CI 2485	Guilder	Holland	6B RHL	79	5/23	35	21	3	1	2.2	17	6	2
CI 2491	Oldambster	Holland	6W RHL	74	5/24	35	33	2	2	52.5	11	5	3
CI 2495	Kroon	Holland	2W RHL	74	5/21	33	39	4	5	56.0	14	5	2
CI 2496	Graven	Holland	6W RHL	75	5/22	34	36	3	4	57.6	6	1	3
CI 2513	Abys. Winter	Abyssinia	6BKRHS	73	5/19	33	46	1	2	58.0	6	3	3
CI 3093	E. Bk. Turkestan	Horst	6BKRHS	64	5/20	31	48	2	2	19.4	5	1	5
CI 3213	6 Row Polders	Belgium	6W RHL	72	5/23	36	30	5	4	42.3	5	1	2
CI 3214	----------	Turkestan	6BKRHS	74	5/18	34	43	1	1	39.5	3	1	4
CI 3344	----------	Caucasus	6B RHL	79	5/15	33	50	4	3	60.7	28	17	2

TABLE 3--AGRONOMIC NOTES AND DISEASE RESISTANCE OF BARLEY VARIETIES GROWN IN MISSOURI, 1943-1948 (CONT'D)

Number	Variety	Source or origin	Description	Survival %	Date headed	Height inches	Lodging %	Mildew		U. nuda	U. nigra	U. hordei	Scald
								fall	spring	%	heads/row	heads/row	
CI 3346	----------	Caucasus	6B RHL	72	5/19	37	39	4	4	27.9	3	1	2
CI 3348	----------	Caucasus	6B RHL	77	5/15	32	63	4	5	18.0	14	4	4
CI 3350	----------	Caucasus	6B RHL	71	5/17	36	40	4	5	63.0	4	2	3
CI 3353	----------	Caucasus	6B RHL	77	5/16	30	50	4	4	32.7	9	4	3
CI 3357	----------	Caucasus	6W RHS	74	5/16	30	31	1	2	68.2	7	3	4
CI 3358	----------	Caucasus	6B RHL	76	5/16	32	38	1	3	1.3	8	1	3
CI 3359	----------	Caucasus	6B RHS	77	5/16	35	34	4	5	30.6	13	1	3
CI 3360	----------	Caucasus	6B RHL	82	5/19	36	45	4	5	23.2	23	15	2
CI 3362	----------	Caucasus	6B RHL	73	5/16	33	39	4	5	28.6	11	2	2
CI 3363	----------	Caucasus	6B RHL	69	5/18	36	34	4	4	4.9	3	2	1
CI 3825	----------	Kashmir	6W RHL	62	5/14	27	15	5	4	47.7	9	0	2
CI 3828	----------	Kashmir	6W RHL	60	5/12	33	32	5	4	17.7	1	0	3
CI 3869	----------	Kashmir	6W RHL	64	5/12	31	40	5	5	40.2	5	1	4
CI 3882	----------	Kashmir	6W RHL	69	5/11	29	63	5	5	30.5	5	1	3
CI 4128	----------	Afghanistan	6B RHL	76	5/13	30	78	1	1	42.1	8	4	5
CI 4202-1	----------	China	6W RHL	84	5/07	31	75	1	1	63.1	1	2	3
CI 4202-2	----------	China	6W RHL	81	5/06	30	73	1	1	52.2	2	0	3
CI 4235	----------	China	6P RHL	66	5/07	33	63	2	1	80.8	2	1	5
CI 4285	----------	Oregon	6W RHL	77	5/13	33	36	4	4	38.5	12	3	4
CI 4290	----------	Transcaucasus	6BKRHL	75	5/16	35	34	1	1	43.6	5	1	2
CI 4291	----------	Transcaucasus	6BKRHS	72	5/19	36	38	4	1	9.4	2	0	4
CI 4292	----------	Transcaucasus	6BKRHS	72	5/19	33	44	2	2	6.6	2	1	5
CI 4293	----------	Transcaucasus	6BKRHS	81	5/17	33	46	1	1	48.3	1	1	5
CI 4294	----------	Transcaucasus	6B RHS	67	5/21	36	35	1	2	20.6	3	0	5
CI 4301	----------	Transcaucasus	6BKRHL	68	5/22	36	41	1	1	36.6	2	0	5
CI 4302	----------	Transcaucasus	6W RHS	61	5/18	34	49	1	2	19.7	1	0	4
CI 4303	----------	Transcaucasus	6BKRHS	67	5/21	37	48	-	4	22.9	1	0	4
CI 4305	----------	Transcaucasus	6BKRHL	67	5/22	37	40	1	2	16.3	3	4	5
CI 4313	----------	Transcaucasus	6B RHL	65	5/22	37	38	1	2	34.2	1	1	4
CI 4317	----------	Transcaucasus	6W RHS	50	5/21	35	43	4	3	55.8	5	1	4
CI 4320	----------	Transcaucasus	6BKRHS	74	5/18	29	31	2	2	23.8	4	4	5
CI 4327	----------	Transcaucasus	6B RHS	61	5/20	34	39	1	1	4.0	1	1	5
CI 4328-1	----------	Transcaucasus	6W RHS	61	5/20	36	43	-	4	.0	6	1	3
CI 4328-2	----------	Transcaucasus	6B RHS	57	5/19	30	45	-	3	2.9	2	1	3
CI 4329	----------	Transcaucasus	6B RHS	60	5/24	34	49	1	1	1.6	1	1	4
CI 4335	----------	Transcaucasus	6B RHS	61	5/23	34	35	1	1	24.3	5	2	4
CI 4952	----------	Russia	6W RHS	66	5/19	31	41	-	3	25.4	8	1	5
CI 4953	----------	Russia	6B RHS	61	5/23	34	51	1	1	2.5	1	0	3
CI 4957	----------	Russia	6B RHS	64	5/15	31	45	-	4	2.4	0	1	2
CI 4958	----------	Russia	6B RHL	67	5/19	35	43	5	5	5.5	2	1	3
CI 4959	----------	Russia	6W RHS	74	5/18	36	43	5	5	.4	6	0	2
CI 4960	----------	Russia	6W RHS	69	5/17	32	44	4	4	.5	3	1	3
CI 4966	----------	Russia	6W RHL	72	5/22	30	64	1	2	.0	1	0	3
CI 4967	----------	Russia	6BKRHL	66	5/28	34	35	1	1	40.0	1	1	2

TABLE 3--AGRONOMIC NOTES AND DISEASE RESISTANCE OF BARLEY VARIETIES GROWN IN MISSOURI, 1943-1948 (CONT'D)

Number	Variety	Source or origin	Descrip-tion	Survi-val %	Date headed	Height inches	Lodg-ing %	Mildew		U. nuda	U. nigra	U. hordei	Scald
								fall	spring	%	heads/row	heads/row	
CI 5009	----------	Caucasus	6W RHL	75	5/20	36	44	2	4	.0	3	1	3
CI 5010	----------	Caucasus	6W RHL	72	5/18	38	39	5	4	44.3	8	3	2
CI 5011	----------	Caucasus	6W RHL	78	5/19	37	39	5	5	1.9	6	1	2
CI 5012	----------	Caucasus	6W RHL	80	5/19	39	44	5	4	7.4	4	3	2
CI 5013	----------	Caucasus	6W RHL	81	5/20	36	39	5	5	14.4	21	8	4
CI 5061	----------	Caucasus	6BKRHS	65	5/21	30	29	1	2	6.1	5	1	5
CI 5062	----------	Caucasus	6W RHL	78	5/17	37	44	-	5	9.4	10	4	3
CI 5085	----------	China	6W RNL	72	5/17	32	75	1	1	20.0	1	1	5
CI 5086	----------	China	6W HNL	62	5/11	32	83	1	1	.8	2	2	4
CI 5087	----------	China	6B HHL	79	5/07	34	83	1	1	9.3	0	0	5
CI 5089	----------	China	6W RHL	78	5/04	27	80	-	1	2.4	1	0	5
CI 5091	----------	China	6W RNL	78	5/08	33	70	3	1	.0	1	0	5
CI 5092	----------	China	6B RHL	78	5/06	28	78	1	1	12.5	1	1	5
CI 5096	----------	Chosen	6B RHL	83	5/10	28	73	2	1	29.9	5	3	5
CI 5134	Koso	Chosen	6W RHL	79	5/12	28	73	3	1	33.3	2	1	5
CI 5135	Rokuben	Chosen	6W RHL	79	5/12	29	75	3	2	22.5	2	0	5
CI 5136	Meimi	Chosen	6W RHL	79	5/12	28	70	3	2	15.3	3	1	5
CI 5138	Zenra	Chosen	6W RHL	79	5/13	28	73	-	1	22.5	1	1	5
CI 5144	Omugi	Chosen	6W RHL	84	5/11	28	68	2	1	66.7	1	0	5
CI 5145	Kido	Chosen	6B RHL	84	5/11	30	75	4	4	42.4	2	0	5
CI 5146	Morsen	Chosen	6W RHL	62	5/11	26	73	3	3	25.2	1	0	5
CI 5151	Sonbaku	Chosen	6W RHL	78	5/12	29	73	-	1	12.6	4	0	5
CI 5152	Nuru Pori	Chosen	6W RHL	78	5/10	31	45	-	1	20.3	1	0	5
CI 5153	Zairai	Chosen	6W RHL	74	5/13	28	63	1	1	14.2	7	2	5
CI 5155	Zura	Chosen	6W RHL	78	5/12	28	75	1	1	39.0	2	3	5
CI 5157	Kawan	Chosen	6B RHL	80	5/12	29	73	2	1	37.9	1	4	5
CI 5159	Tongu	Chosen	6B RHL	66	5/16	32	61	3	2	15.6	1	1	5
CI 5165	Daka	Chosen	6B RNL	66	5/14	29	68	1	1	5.7	3	2	5
CI 5173	Chusi	Chosen	6W RNL	78	5/13	27	65	1	1	1.7	2	1	5
CI 5175	Tongus	Chosen	6W RNL	75	5/15	28	66	1	1	11.8	1	1	5
CI 5176	Hokudo	Chosen	6W RNL	78	5/09	25	80	1	1	.0	1	1	5
CI 5177	Zeurga	Chosen	6W RNL	83	5/13	28	68	1	1	2.4	6	2	5
CI 5178	Zamugi	Chosen	6W RNL	64	5/12	27	73	1	1	1.6	1	1	5
CI 5179	Hoku	Chosen	6W RNL	79	5/13	29	66	-	1	.0	2	4	5
CI 5180	Kada	Chosen	6W RHL	76	5/13	27	78	1	1	.0	1	1	5
CI 5181	Akda	Chosen	6W RNL	77	5/11	29	73	1	2	3.8	1	3	5
CI 5183	Tonsaru	Chosen	6W RNL	81	5/12	29	78	-	3	9.5	2	1	5
CI 5185	Saru	Chosen	6W RNL	80	5/12	29	80	1	1	.0	1	1	4
CI 5187	Nohadak	Chosen	6W RNL	77	5/14	28	78	1	1	.2	1	0	5
CI 5189	Zehra	Chosen	6W RNL	68	5/14	27	81	2	1	16.5	3	4	5
CI 5208	Tongpori	Chosen	6W RHL	66	5/14	28	69	1	1	8.9	1	1	5
CI 5213	Mugish	Chosen	6B RHL	68	5/14	30	64	1	1	37.5	2	1	5
CI 5216	Shumugi	Chosen	6W RHL	66	5/16	27	83	1	1	12.6	5	1	5
CI 5219	Mugiza	Chosen	6W RHL	68	5/15	28	78	1	1	16.6	4	1	5
CI 5222	Shumaki	Chosen	6W RHL	74	5/12	29	73	1	1	17.3	1	1	5

TABLE 3--AGRONOMIC NOTES AND DISEASE RESISTANCE OF BARLEY VARIETIES GROWN IN MISSOURI, 1943-1948 (CONT'D)

Number	Variety	Source or origin	Description	Survival %	Date headed	Height inches	Lodging %	Mildew fall	Mildew spring	U. nuda %	U. nigra heads/row	U. hordei heads/row	Scald
CI 5224	Kimak	Chosen	6B RHL	66	5/13	29	75	1	1	18.7	2	1	5
CI 5225	Denrai	Chosen	6B RHL	82	5/13	30	65	1	1	14.1	1	1	5
CI 5226	Baromugi	Chosen	6B RHL	83	5/12	32	65	1	3	20.0	3	3	5
CI 5229	Seibaku	Chosen	6B RHL	75	5/11	28	68	2	2	5.1	1	1	5
CI 5236	Borido	Chosen	6B RHL	70	5/14	27	78	5	3	21.1	2	1	5
CI 5238	Dobaku	Chosen	6W RHL	73	5/13	28	60	-	1	.0	2	1	5
CI 5239	Rangubori	Chosen	6W RHL	74	5/13	30	65	1	1	7.8	1	1	5
CI 5242	Kipo	Chosen	6W RHL	76	5/14	27	58	1	1	17.0	8	1	5
CI 5244	Bakson	Chosen	6W RHL	69	5/14	27	65	1	1	15.9	5	1	5
CI 5245	Borimuru	Chosen	6W RHL	73	5/15	29	53	1	1	11.4	1	1	5
CI 5248	Gubori	Chosen	6W RHL	74	5/14	29	73	5	4	4.3	2	1	5
CI 5251	Shomuru	Chosen	6B RHL	84	5/13	32	40	1	2	13.9	6	8	5
CI 5252	Tongubori	Chosen	6B RHL	82	5/13	34	28	1	2	12.5	2	1	5
CI 5255	Shonan	Chosen	6B RHL	82	5/12	30	80	1	1	50.0	3	1	5
CI 5259	Karubori	Chosen	6B RHL	81	5/13	29	75	1	1	8.4	2	2	3
CI 5262	Kogendo	Chosen	6W RHL	84	5/10	30	78	1	1	18.8	3	1	5
CI 5529	C. C. Sel. 2	Hybrid	6B RHL	89	5/14	28	75	1	1	16.6	3	1	5
CI 5560	----------	Asafute	6W RHL	77	5/20	34	29	5	4	5.1	7	5	5
CI 5561	----------	Asafute	6B RHS	74	5/17	31	50	-	2	47.3	17	9	2
CI 5562	----------	Asafute	6W RHS	76	5/14	30	53	1	1	62.4	6	5	2
CI 5565	----------	Dagestan	6B RHL	45	5/18	--	50	-	1	18.6	1	0	3
CI 5930	----------	China	6W RNL	72	5/09	29	78	1	1	30.3	1	1	5
CI 5931	----------	China	6W RNL	73	5/10	27	75	1	1	11.7	2	1	5
CI 5938	----------	China	6W RNL	65	5/11	28	55	1	1	4.3	0	7	5
CI 5950	Dutch Winter	Holland	6W RHL	78	5/18	33	34	3	4	74.0	11	2	4
CI 6116	Orel Sel.	CI 351	2W RHL	65	5/16	31	17	1	2	33.0	7	4	5
CI 6125	Tennessee Winter	Texas	6W RHS	74	5/14	27	50	5	5	11.6	22	11	2
CI 6126	Tennessee Winter	Texas	6B RHL	78	5/14	27	45	5	5	27.4	24	8	3
CI 6185	Deciduouslem	China	6W RNL	59	5/08	29	50	1	2	.0	9	1	5
CI 6267	Sm. Awn 203	Hybrid	6W SHS	78	5/11	35	53	5	4	53.5	4	0	2
CI 6271	Sm. Awn 1	Hybrid	6W SHS	77	5/11	34	40	2	4	44.9	4	1	2
CI 6273	Poltawa	Russia	6W RHS	71	5/17	30	59	1	1	27.0	9	2	3
CI 6274	Don	Russia	6B RHL	57	5/19	37	43	2	3	14.8	12	1	3
CI 6331	----------	Afghanistan	6B RHL	60	5/18	25	73	1	1	1.7	3	1	3
CI 6332	----------	Afghanistan	6B RHL	66	5/17	27	73	1	1	54.2	2	0	3
CI 6351	Harlan Hybrid	Sel. C. C.	6W RHL	74	5/18	31	33	5	5	98.4	16	6	3
CI 6485	Grossklappige	Germany	6W RHL	77	5/16	31	31	5	4	45.9	15	3	1
CI 6486	Berg	Germany	6B RHL	76	5/20	31	26	5	3	41.2	14	4	2
CI 6495	Smooth Awn	Hybrid	6B SHS	61	5/17	32	27	5	4	75.5	6	1	3
CI 6596	Vindicat	Holland	6B RHL	72	5/22	36	30	1	1	7.5	13	4	3
CI 6685	----------	Asafute	6B RHS	78	5/18	33	48	1	2	26.3	12	9	3
CI 6686	----------	Asafute	6W RHS	80	5/14	32	46	-	1	18.6	8	5	2
CI 6702	----------	Tiflis	6W RHL	80	5/15	35	43	4	4	80.4	11	6	5
CI 6051	Mo. E. Beardless (Check)	----------	6W HH	82	5/06	35	79	-	5	16.0	10	5	5
CI 6561	Reno (Check)	----------	6W RH	88	5/12	33	56	-	5	47.7	16	15	2

* CI number refers to the accession number of the Division of Cereal Crops and Diseases, U. S. Department of Agriculture.
** B number refers to the accession number of the Missouri Agricultural Experiment Station.

collection were obtained from the mimeographed report of the Division of Cereal Crops and Diseases, U. S. Department of Agriculture (Wiebe, 14).*

The method of obtaining data and the years in which observations were made is discussed separately for each character studied. A list of varieties superior in these respects is also presented.

Winter Survival.—Estimates of the winter survival were made in each of the five years, 1944 to 1948 inclusive, for varieties in Groups 1 to 5 and for each of the six years, 1943 to 1948 inclusive, for varieties in Group 6. The five-year average survival for each variety in Groups 1 to 5, and the six-year average survival for each variety in Group 6, are reported in Table 3. Weighted averages are used for varieties not grown the full five- or six-year period.

Reno (CI 6561) and Missouri Early Beardless (CI 6051) are standard check varieties at the Missouri Agricultural Experiment Station. In addition to being the leading varieties in acreage in Missouri, they represent a range in hardiness which makes them useful to compare with new varieties and strains. Reno is one of the more hardy varieties available, while Missouri Early Beardless is about the least hardy variety that could be recommended under Missouri conditions. In these tests the survivals of these varieties were as follows:

	Per cent survival	
	Reno	*Missouri Early Beardless*
5-year period, 1944 to '48	89	82
6-year period, 1943 to '48	88	82

These data would indicate that the average survival of the varieties grown during the 5-year period may be compared directly with those grown during the 6-year period. It should be stated that these varieties were grown through a cycle of years in which winter killing was generally regarded to have been rather light. Even so, some killing was noted each year in every variety. Most of the killing was the direct effect of low temperatures, although heaving was also noticed in some years.

Of the 249 varieties studied, 50 were found to have an average survival of 82 per cent or better for the years they were grown, which means they were equal to or better than Missouri Early Beardless. These varieties listed in the order of their average survival are:

Variety			Per cent survival	Variety			Per cent survival
Tennessee winter type varieties							
CI	7525*	Ludwig	92	CI	4581	Purdue 21	86
CI	7523	Purdue 1101 Sel.	91	CI	4678	Kentucky 6	86
CI	6050	Kentucky 1	90	CI	6148	Kentucky 2	86
CI	6377	Admire	90	CI	7033	Woodwin	86
CI	7070	Kansas Southeast	90	CI	4677	Kentucky 36	85
CI	6561	Reno	89	CI	3543	Tennessee Winter 52	82

*Description: Column 1, No. rows; col. 2, seed color—B blue, Bk black, P purple, W white; col. 3, awn type—R rough, S smooth, H hooded; col. 4, seed type—H hulled, N naked; col. 5, rachilla hairs—S short, L long.

Variety			Per cent survival	Variety			Per cent survival
CI	277	Scottish Pearl	88	CI	6034	Tennessee Winter	82
CI	7075	Kirwin	88	CI	7072	Ohio 1	82
CI	2036	Michigan Winter	87	CI	7157	Brier	82
CI	6007	Ward	87				
Introductions							
CI	534	Alaska	85	CI	6280	Poland	84
Hooded varieties							
CI	7039	Tucker	83		B659**	Sel. Kinroku	82
CI	6051	Mo. E. Beardless	82		B404	Sel. Mo. E. Beardless	82
Varieties from world collection							
CI	895	Cusada	91	CI	5251	Shomuru	84
CI	170	Mensury	89	CI	5262	Kogendo	84
CI	5529	C. C. Sel. 2	89	CI	741	Nu Er Ta	83
CI	876	Tennessee Winter	88	CI	2420	--------	83
CI	896	Arabel	88	CI	5096	--------	83
CI	257	Tennessee Winter	87	CI	5177	Zeurga	83
CI	1117	Khayyam	86	CI	5226	Baromugi	83
CI	898	Omar	85	CI	1266	Sabbaton	82
CI	2033	Ohio Winter	85	CI	3360	--------	82
CI	206	Han River	84	CI	5225	Denrai	82
CI	4202-1	--------	84	CI	5252	Tongubori	82
CI	5144	Omugi	84				
CI	5145	Kido	84				

* CI refers to accession number of the Division of Cereal Crops and Diseases, U. S. Department of Agriculture.

** B refers to accession number of the Missouri Agricultural Experiment Station.

The superior hardiness of the Tennessee Winter type barleys is clearly demonstrated. Nineteen of the 23 varieties included in this group were equal or superior to Missouri Early Beardless. The three varieties with the highest survival were CI 7525 Ludwig, CI 7523 Purdue 1101 Selection, and CI 895 Cusada. The hardiness of Ludwig and Purdue 1101 Sel. has been noted previously in the uniform nurseries. Introductions from the world collection with superior hardiness are CI 170 Mensury from Manchuria; CI 206 Han River from China; and CI 5144 Omugi, CI 5145 Kido, CI 5251 Shomuru, and CI 5262 Kogendo from Chosen. Only three other hooded strains equaled Missouri Early Beardless in hardiness.

Date of Heading.—The date of heading was recorded for each variety in each year grown. The five-year averages of the heading date for varieties in Groups 1 to 5 and the six-year averages for varieties in Group 6 are reported in Table 3. The earliest variety was CI 5089 from China with May 4 as the average heading date and the latest variety was CI 592 Winter Club with June 12 as the average date of heading. The average date of heading of most varieties was between May 12 to 15. As most varieties fall within a range of maturity that would be satisfactory from an agronomic standpoint, no grouping of varieties on the basis of heading is made here.

Height.—The height, in inches, was recorded for all varieties and selections in two years only, 1947 and 1948. The average height of each selection for these two years is reported in Table 3. No detailed grouping of varieties on the basis of height is made here.

Lodging.—The percentage lodging for each variety and selection was estimated in two of the years, 1947 and 1948. Lodging notes were taken on each variety in the *U. nigra* and the *U. hordei* smut nurseries after the plants were dead ripe, and the averages of these two readings were used as the estimate of lodging for that year. The average lodging for the two seasons is reported in Table 3. Lodging percentages reported here are rather high but it should be remembered that the estimates were made at what would normally be a late stage of maturity for harvesting by combine.

Varieties with 30 per cent or less lodging are listed here:

Variety		Per cent lodging	Variety		Per cent lodging
Tennessee winter type varieties					
CI 7523	Purdue 1101 Sel.	28			
Introductions					
CI 592	Winter Club	20			
Hooded varieties					
B355	Mo. E. Beardless Sel.	30	B495	Mo. E. Beardless Sel.	28
Varieties from world collection					
CI 3825	--------	15	CI 5061	--------	29
CI 6116	Orel Sel.	17	CI 5560	--------	29
CI 1108	Carytid	20	CI 895	Cusada	30
CI 2485	Guilder	21	CI 1117	Khayyam	30
CI 6486	Berg	26	CI 2460	Lochink	30
CI 6495	Smooth Awn	27	CI 3213	Polders	30
CI 5252	Tongubori	28	CI 6596	Vindicat	30

Several of these varieties mature rather late and the low lodging estimate in such cases is perhaps related to their maturity. Late maturing strains are: Purdue 1101 Sel., Winter Club, Carytid, Guilder, Berg, CI 5061, CI 5560, Polders and Vindicat. The dearth of stiff-strawed selections suggests the magnitude of the problem of breeding new varieties, improved in this respect.

Resistance to *U. nuda* Loose Smut.—Reaction of the varieties to brown loose smut, *Ustilago nuda* (Jens.) Rostr., was determined, using artificial inoculations. Three heads were inoculated by injecting a spore suspension into the spikelets within 1 to 2 days after pollination. A rubber bulb attached to a hypodermic needle was used in making the inoculations. A composite of smutted heads from several varieties was used to prepare inoculum for infections reported in 1944 through 1946, and collections of smut from fields of Reno were used to obtain infections reported in 1947 and 1948. Seed from each inoculat-

ed head was planted in a one-foot row, and the average percentage of smutted heads was determined. An average of the infection percentages obtained by this method for the years 1944 to 1948 is reported in Table 3. The number of years in which inoculations were made and in which infection percentages are included in these averages, varies from one to five. Varieties that were found to be susceptible were not reinoculated, one reading with high infection being considered sufficient to demonstrate susceptibility; varieties that gave low infections were reinoculated to check their resistance. Details of the inoculation method have been reported by Poehlman (7) and complete reports on the reactions of most of the varieties studied here, have also been made previously by Poehlman (8, 9).

Varieties in which the infection does not exceed 5.0 per cent are arbitrarily classified as resistant. Fifty-seven varieties are classified as resistant on this basis as follows:

Variety		Number of years tested	Average per cent smutted heads	Variety		Number of years tested	Average per cent smutted heads
Hooded varieties and selections							
CI 6235	Woods Hooded	3	1.5	B467	Sel. Kinroku	5	1.2
CI 6477	Brugh 76	3	1.1	B468	Sel. Kinroku	4	4.6
CI 6491	Brugh 23	4	0.4	B659	Sel. Kinroku	3	2.8
CI 6563	Hooded 10	5	2.3	B351	Sel. Mo. E. Beardless	5	0.9
CI 6571	Iredell	3	0	B404	Sel. Mo. E. Beardless	5	1.4
CI 6574	Hooded 16	4	4.6	B411	Sel. Mo. E. Beardless	5	0.2
CI 6998	Huga	2	0	B472	Sel. Mo. E. Beardless	5	0
CI 7026	N. C. Hooded 26	5	0	B502	Sel. Mo. E. Beardless	4	0.2
CI 7038	York Hooded	2	0	B507	Sel. Mo. E. Beardless	4	0
CI 7042	Clemson Hooded	2	2.8	B538	Sel. Mo. E. Beardless	4	0
CI 7074	Marett Hooded 4	2	0	B539	Sel. Mo. E. Beardless	4	2.5
Varieties from world collection							
CI 206	Han River	3	3.4	CI 5086	----------	5	0.8
CI 898	Omar	4	4.4	CI 5089	----------	2	2.4
CI 1002	Clancy	5	1.0	CI 5091	----------	4	0
CI 1412	Abundio	4	0	CI 5173	Chusi	5	1.7
CI 2485	Guilder	2	2.2	CI 5176	Hokudo	4	0
CI 3358	----------	4	1.3	CI 5177	Zeurga	3	2.4
CI 3363	----------	4	4.9	CI 5178	Zamugi	5	1.6
CI 4327	----------	5	4.0	CI 5179	Hoku	5	0
CI 4328-1	----------	5	0	CI 5180	Kada	5	0
CI 4328-2	----------	5	2.9	CI 5181	Akda	4	3.8
CI 4329	----------	4	1.6	CI 5185	Saru	5	0
CI 4953	----------	3	2.5	CI 5187	Nohadak	5	0.2
CI 4957	----------	5	2.4	CI 5238	Dobaku	4	0
CI 4959	----------	5	0.4	CI 5248	Gubori	2	4.3
CI 4960	----------	5	0.5	CI 5938	----------	2	4.3
CI 4966	----------	5	0	CI 6185	Deciduouslem	1	0
CI 5009	----------	4	0	CI 6331	----------	3	1.7
CI 5011	----------	3	1.9				

Attention is called here to resistance to the *U. nuda* loose smut in the hooded varieties of winter barley. It will also be noted that many varieties of for-

eign origin, particularly varieties from Russia, Chosen, and China, were resistant here to this type of barley smut.

Resistance to *U. nigra* Loose Smut.—Resistance to *Ustilago nigra*, Tapke, was tested during the five-year period 1944 to 1948 inclusive by artificial inoculation. Inoculations were made by immersing five grams of seed wrapped in cheesecloth in a spore suspension and placing in a partial vacuum, obtained by exhausting the air from a bell jar with a water pump, for two 15-minute periods. Inoculum used in 1944 was a composite of seven races of *U. nigra* (Tapke, 10) obtained from Dr. V. F. Tapke, U. S. Department of Agriculture. Composites of smutted heads, collected from the nursery, were used as sources of inoculum in 1945, 1946, and 1947. In 1948, nine races were obtained from Dr. Tapke and composited in the preparation of the inoculum. The inoculated seed was planted in a five-foot row and the number of smutted heads counted. Observations reported are the average number of smutted heads per five-foot row for the five-year period. Where varieties were not inoculated in each of the five years, averages are based on the number of years in which data is available.

The inoculation method used here did not give high infections but is believed to be satisfactory for sorting the resistant from the susceptible varieties. The 23 rough-awned Tennessee Winter types averaged 13 smutted heads per five-foot row for the five-year period. Reno averaged 16 heads per five-foot row. In view of these results a variety averaging only one head or less per row is classified here as resistant. Of the 249 varieties and strains tested, 63 could be classed as resistant on this basis. In eight of these varieties, no smutted heads were obtained. They are as follows:

Hooded varieties

CI 6574 Hooded 16
B467 Sel. Kinroku
B659 Sel. Kinroku

Varieties from world collection

CI 4957 (Russia)
CI 5087 (China)
B411 Sel. Mo. Early Beardless
B538 Sel. Mo. Early Beardless
CI 5938 (China)

To suppplement these studies, 15 varieties were inoculated separately with the nine individual races of *U. nigra* in 1948, using the same inoculation technique described here. Four of the eight varieties listed above were among those inoculated with individual races. On the basis of one year's results, CI 6574 and B467 were resistant to all nine races; B411 and B538 were resistant to six of the nine races. CI 5187, which averaged 1 head per row in the five-year period, was also inoculated with these individual races and found to be resistant to all nine of the races. These results would indicate that varieties which in this report did not exceed an average of more than one head per row probably carried resistance to a large number if not all of these races. Additional testing of resistant varieties with individual races should be carried out.

Resistance to Covered Smut.—The resistance of varieties and selections to covered smut, *Ustilago hordei* (Pers.) Lagerh., was also studied during the five-year period 1944 to 1948 inclusive. Procedure in inoculation of the seed was identical with that used with the *U. nigra* loose smut. Heads of each of the 13 races of *U. hordei* described by Tapke (11) were obtained from Dr. Tapke, and composited in preparing inoculum for 1944. Smutted heads collected from the nursery, augmented by collections of *U. hordei* from commercial fields in Missouri, were used in preparing inoculum in 1945, 1946 and 1947. In 1948 a composite of all 13 races obtained new from Dr. Tapke was used. Infections were recorded by counting the smutted heads per five-foot row in which had been planted five grams of inoculated seed.

Infections obtained by this method of inoculation, as with *U. nigra*, were rather low. For the five-year period Reno averaged 15 smutted heads per five-foot row, although the entire group of 23 rough-awned Tennessee Winter types averaged only 5 heads per row. In 34 of the 249 varieties studied, no smutted heads were found during the five-year period.

These varieties are as follows:

Rough awned Tennessee winter types

CI 646	Tenkow	CI 7157	Brier
CI 6372	Randolph	CI 7525	Ludwig

Smooth awned varieties

CI 6569	Jackson

Introductions

CI 534	Alaska

Hooded varieties

B467	Sel. Kinroku

Introductions from world collection

CI 1231	Abyssinian	CI 5087	----------
CI 2202	Black Russia	CI 5089	----------
CI 2350	----------	CI 5091	----------
CI 3825	----------	CI 5135	Rokuben
CI 3828	----------	CI 5144	Omugi
CI 4202	----------	CI 5145	Kido
CI 4291	----------	CI 5146	Morsen
CI 4294	----------	CI 5151	Sonbaku
CI 4301	----------	CI 5152	Nuru Pori
CI 4302	----------	CI 5187	Nohadak
CI 4303	----------	CI 5565	----------
CI 4953	----------	CI 6267	Smooth Awn 203
CI 4959	----------	CI 6332	----------
CI 4966	----------		

In 1948, 15 varieties were inoculated separately with each of the 13 races of covered smut using the inoculation technique already described. Five of the 15 varieties were resistant to all races on the basis of one year's results. Two

of these, B467 Kinroku selection and CI 5187 Nohadak, are listed above as being free of smut, while two, B355 Mo. Early Beardless Selection and CI 6574 Hooded 16, averaged only one head per five-foot row as reported in Table 3. Eight selections from Missouri Early Beardless which averaged from 1 to 3 heads, Table 3, were resistant to 9 races. One Missouri Early Beardless selection which averaged 14 smutted heads per five-foot row was susceptible to nine races. It would thus appear that varieties with low infection counts here should be resistant to many if not all of the races of covered smut. Additional testing of these lines with individual races would be desirable.

Resistance to Mildew.—Mildew, *Erysiphe graminis hordei*, Marchal., was present in epidemic proportions in each spring, except 1947, during the six-year period 1943 to 1948, and also in the falls of 1944 and 1946. Thus six observations were obtained on the reaction of varieties in Groups 1 to 5 and seven observations on the reaction of varieties in Group 6. Varieties were rated using a scale of 1 to 5 as follows: 1 = resistant, 2 = moderately resistant, 3 = intermediate, 4 = moderately susceptible, and 5 = susceptible.

Observations on the reaction of varieties were not always consistent, especially comparisons of the fall and spring epidemics, indicating the same physiologic race of the mildew organism was not always present. The spring barley varieties used to differentiate races of mildew (Mains and Dietz, 5, Tidd, 12, and Cherewick, 3) were grown in the greenhouse in the fall of 1946 and dusted with mildew which developed on plants of Reno that had been brought in from the field. Reaction of the differential varieties indicated that Race 2 was present on the Reno. Reaction of these differential varieties growing in the field the following spring indicated that Race 10 was present. Field notes on these spring varieties were not taken until July 3 and by that time all winter barleys had been harvested. Mildew did not develop on the earlier maturing winter barleys in amounts sufficient to rate them for reaction in that spring season.

The average mildew rating of all varieties is recorded in Table 3. The average from the two fall readings is listed separately from the spring readings since the greatest discrepancy was between these two groups of readings. Two observations are apparent: (1) the very limited number of resistant varieties in Groups 1 to 5, which includes the varieties now grown in the United States, and (2) the large numbers of varieties from the world collection, Group 6, which have excellent resistance. From the latter group, 66 varieties have been rated resistant to both fall and spring infections. Many others were resistant to either fall or spring reading and moderately resistant to the other reading. Many of these resistant varieties are introductions from Chosen or China. The only varieties from the first five groups highly resistant to both fall and spring readings are CI 7073 Marett Awnless and B495 Missouri Early Beardless. Varieties with moderate resistance are Kentucky 1, Poland, Wong, Calhoun, Sunrise, Tucker, and Missouri Early Beardless Selections B351 and B355.

An individual listing of all varieties from the world collection that are

resistant to mildew will not be made here because of the large number of strains involved. Many of these are listed in Table 4.

Resistance to Scald.—Natural epidemics of scald, *Rhynchosporium secalis* (Oud.) J. J. Davis, occurred in the nursery in such proportions that notes on varietal resistance could be obtained in 1944 and 1945. Notes were also taken on varieties growing in the uniform yield nursery in 1947. Varieties were classified on a scale of 1 to 5 as follows: 1 = resistant, 2 = moderately resistant, 3 = intermediate, 4 = moderately susceptible, and 5 = susceptible. Only sparsely scattered or no lesions were found on resistant varieties. Susceptible varieties contained many conspicuous lesions and water soaked blotches and were soon defoliated by this disease. In both 1944 and 1945 scald infections appeared earlier than the mildew and notes could be taken before mildew damage reached epidemic proportions. Results reported in Table 3 are the average of the two years' data.

Varieties rated 1 for scald in each of the two years are the following:

Rough awned Tennessee winter types

CI 277	Scottish Pearl	CI 7070	Kansas South East
CI 2159	Wisconsin Winter	CI 7075	Kirwin
CI 4677	Kentucky 36	CI 7157	Brier
CI 4678	Kentucky 6	CI 7523	Purdue 1101 Sel.*
CI 6377	Admire		

*Notes in 1947 only.

Introductions

CI 534	Alaska

Hooded varieties

CI 3384	Tennessee Beardless 5

Introductions from world collections

CI 170	Mensury	CI 1107	Cartouch
CI 206	Han River	CI 2033	Ohio Winter
CI 257	Tennessee Winter	CI 2420	----------
CI 876	Tennessee Winter	CI 3363	----------
CI 895	Cusada	CI 6485	Grossklappige
CI 896	Arabel		

Many varieties from the rough-awned Tennessee Winter type barleys were found to be resistant to these natural infections of scald. In addition to the nine varieties listed above as resistant, eight varieties are rated 2, moderately resistant. Resistance in Wisconsin Winter (CI 259) and a variety called Winter Tennessee (CI 4633), not included here, has been reported previously by Riddle and Suneson (13). The hooded varieties were mostly susceptible. The varieties in the world collection from Chosen, many of which are resistant to mildew and one or more of the smuts, were without exception extremely susceptible to scald. If these varieties are used in breeding programs for sources of mildew or smut resistance, it will be necessary to cross them with varieties resistant to scald or this disease may become more serious than it has been heretofore.

VARIETIES WITH COMBINED RESISTANCE

TABLE 4--AVERAGE PERFORMANCE OF VARIETIES SUPERIOR FOR TWO OR MORE QUALITIES

Variety	Survival %	Date headed	Mildew fall	Mildew spring	U. nuda %	U. nigra heads/row	U. hordei heads/row	Scald
Tennessee winter types								
CI 277	88	5/13	5	5	16.8	15	10	1
CI 4677	85	14	4	3	27.7	3	1	1
CI 4678	86	13	5	5	16.5	10	8	1
CI 6377	90	14	5	5	30.0	7	4	1
CI 7070	90	14	5	5	---	22	5	1
CI 7075	88	13	5	5	21.6	12	6	1
CI 7157	82	8	4	2	67.7	4	0	1
CI 7523	91	28	5	4	62.1	6	5	1
CI 7525	92	15	4	5	65.9	2	0	4
Introductions								
CI 534	85	5/14	5	4	32.8	3	0	1
Hooded varieties								
CI 6491	81	5/10	5	5	0.4	1	3	5
CI 6571	77	13	5	3	0	1	5	5
CI 6574	77	12	5	4	4.6	0	1	5
B467	75	7	-	5	1.2	0	0	5
B659	82	7	-	5	2.8	0	2	5
B404	82	6	5	5	1.4	25	11	5
B411	77	7	5	5	0.2	0	2	5
B472	76	10	4	3	0	1	1	5
B502	79	8	5	5	0.2	1	1	5
B507	76	9	5	5	0	1	2	5
B538	78	9	5	5	0	0	3	5
B539	78	8	5	5	2.5	1	1	5
Varieties in world collection from Russia, Caucasus, Transcaucasus and related areas								
CI 2202(BK)*	78	5/19	1	1	23.8	1	0	3
CI 2350(BK)	75	19	1	3	20.4	1	0	3
CI 3828	60	12	5	4	17.7	1	0	3
CI 4302	61	18	1	2	19.7	1	0	4
CI 4303(BK)	67	21	-	4	22.9	1	0	4
CI 4327	61	20	1	1	4.0	1	1	5
CI 4329	60	24	1	1	1.6	1	1	4
CI 4953	61	23	1	1	2.5	1	0	3
CI 4957	64	15	-	4	2.4	0	1	2
CI 4959	74	18	5	5	0.4	6	0	2
CI 4966	72	22	1	2	0	1	0	3
CI 5565	45	18	-	1	18.6	1	0	3
CI 6331	60	18	1	1	1.7	3	1	3
Varieties in world collection from Chosen								
CI 5144	84	5/11	2	1	66.7	1	0	5
CI 5145	84	11	4	4	42.4	2	0	5
CI 5146	62	11	3	3	25.2	1	0	5
CI 5152	78	10	-	1	20.3	1	0	5
CI 5173(N)**	78	13	1	1	1.7	2	1	5
CI 5175(N)	75	15	1	1	11.8	1	1	5
CI 5176(N)	78	9	1	1	0	1	1	5
CI 5177(N)	83	13	1	1	2.4	6	2	5
CI 5178(N)	64	12	1	1	1.6	1	1	5
CI 5179(N)	79	13	-	1	0	2	4	5
CI 5180	76	13	1	1	0	1	1	5
CI 5181(N)	77	11	1	2	3.8	1	3	5
CI 5185(N)	80	12	1	1	0	1	1	4
CI 5187(N)	77	14	1	1	0.2	1	0	5

* BK = Black ** N = Naked

TABLE 4--AVERAGE PERFORMANCE OF VARIETIES SUPERIOR FOR TWO OR MORE QUALITIES (CONT'D)

Variety	Survival %	Date headed	Mildew fall	Mildew spring	U. nuda %	U. nigra heads/row	U. hordei heads/row	Scald
Varieties in world collection from Chosen (cont'd)								
CI 5225	82	5/13	1	1	14.1	1	1	5
CI 5238	73	13	-	1	0	2	1	5
CI 5255	82	12	1	1	50.0	3	1	5
Varieties in world collection from China and Manchuria								
CI 170	89	5/12	5	5	24.8	13	7	1
CI 206	84	11	5	5	3.4	36	20	1
CI 1266	82	8	1	1	19.6	1	1	5
CI 4202-1	84	7	1	1	63.1	1	2	3
CI 5086(H*,N)	62	11	1	1	0.8	2	2	4
CI 5087(H)	79	7	1	1	9.3	0	0	5
CI 5089	78	4	-	1	2.4	1	0	5
CI 5091(N)	78	8	3	1	0	1	0	5
CI 5938(N)	65	11	1	1	4.3	0	7	5
Varieties in world collection of hybrid origin								
CI 895	91	5/12	5	4	45.8	15	8	1
CI 896	88	11	5	5	32.7	17	6	1
CI 898(2R)**	85	12	5	5	4.4	9	5	4
Varieties in world collection of Tennessee winter type								
CI 257	87	4/12	5	5	21.7	10	4	1
CI 876	88	11	5	4	53.6	19	16	1
CI 2033	85	13	-	3	27.3	2	1	1
CI 2420	83	12	5	5	39.5	9	6	1
Varieties in world collection of miscellaneous origin								
CI 1412	79	5/20	2	2	0	1	1	2

* H = Hooded ** 2R = 2-row

Varieties in which hardiness is combined with resistance to one or more diseases, or in which resistance to two or more diseases is found are listed in Table 4. The 177 varieties from the world collection are here subdivided into seven groups largely on the basis of geographic origin. Data which denote hardiness or resistance are underscored. From this summary the potential use of these varieties as breeding material may be evaluated.

COMPARATIVE PERFORMANCE BY GROUPS

Some interesting observations can be made concerning the performance and the potential value of each group of varieties as a source of breeding material.

In Table 5 the number of varieties in each group superior in winter hardiness and resistant to each of the diseases are compared. The 177 varieties in the world collection again have been subdivided into seven groups, largely on the basis of geographic origin.

1. **Rough-awned Tennessee Winter Varieties.**—This group contains the largest proportion of winter hardy varieties, and among them, the hardiest varieties tested. It also contains a large number of varieties resistant to scald—

TABLE 5--NUMBERS OF SUPERIOR VARIETIES FROM EACH GROUP

Variety groups	Number of varieties	Number of varieties resistant to					
		survival	mildew	U. nuda	U. nigra	U. hordei	scald
1. Tennessee winter types	23	19			1	4	9
2. Smooth awned	8					1	
3. Introductions and miscellaneous	10	2	1			1	1
4. Composite crosses	5						
5. Hooded	30	4	1	22	11	1	1
6. World collection							
a. Russia, Caucasus, Transcaucasus, and related areas.	65	1	18	15	15	15	1
b. Chosen	48	10	30	11	19	7	
c. China	28	5	15	6	15	4	2
d. Europe	11		1	1			2
e. Hybrid	10	5	1	1	1	1	2
f. Tenn. winter type	8	4					4
g. Miscellaneous*	7		1	1	1		4

* Miscellaneous varieties include 4 from Abyssinia and 1 each from Mexico, Persia, and Japan.

9 resistant and 8 moderately resistant. All varieties of this group are susceptible to the *U. nuda* loose smut and with one possible exception to *U. nigra* loose smut. They show varied reactions to covered smut, four without any infection and three averaging only one head per row. Only Kentucky No. 1 could be classed as even moderately resistant to mildew.

2. **Smooth-awned Varieties.**—None of these varieties was as hardy even as Missouri Early Beardless and none showed resistance to the diseases studied here, except possibly resistance of Jackson to covered smut.

3. **Introductions and Miscellaneous.**—The two varieties with the best winter hardiness in this group are Alaska and Poland. These exceeded Missouri Early Beardless but did not compare with Reno in survival. Most other varieties in this group were lacking in hardiness, especially the two awnless varieties. Four of these varieties, Calhoun, Awnless, Marett Awnless, and Winter Club, were not tested for resistance to *U. nuda* loose smut or covered smut. None of the varieties tested was resistant to any of the smuts, with the possible exception of Alaska, no covered smut being observed in this variety. Alaska was resistant to scald; Olympia and Poland were moderately resistant. The two awnless varieties and Sunrise were resistant to mildew; ratings of Poland, Wong, and Calhoun indicate them to be moderately resistant.

4. **Selections From Composite Crosses.**—None of the varieties in this group proved to be as winter hardy as Missouri Early Beardless or resistant to any of the diseases.

5. **Hooded Varieties.**—The hooded varieties have proven to be an excellent source of resistance to the three smuts. Twenty-two were found to be resistant to *U. nuda*. Eleven of these were resistant to *U. nigra*. One variety, B467 Kinroku selection, was also resistant to covered smut and six varieties, CI 6574, B468, B355, B472, B 502, and B539, averaged only one head of cov-

ered smut per row. One variety was resistant to mildew and one to scald but neither of these was resistant to any of the smuts. This group is mostly below Missouri Early Beardless in hardiness, only three varieties being equivalent to it.

6. **World Collection.**—The 177 varieties in the world collection can be divided into seven groups (Tables 4 and 5) on the basis of geographic origin. The largest group of varieties originated as introductions from Russia, Caucasus, Transcaucasus and related areas. The next three groups in order of size originated as introductions from Chosen, China (including one variety from Manchuria), and miscellaneous countries in western Europe. Ten varieties are of hybrid origin and cannot be grouped on basis of geographic origin. Eight varieties are evidently Tennessee Winter types even though some were obtained in Europe. Four of the remaining group of seven miscellaneous varieties were obtained from Abyssinia and one each from Mexico, Persia, and Japan.

a. Varieties from Russia, Caucasus, Transcaucasus, and related areas.—Varieties in this group were generally lacking in hardiness, only one surviving even as well as Missouri Early Beardless. And most of them were later in maturity than varieties now grown in Missouri. Eleven of these varieties were resistant to both *U. nigra* loose smut and covered smut and six varieties were also resistant to *U. nuda* loose smut. In addition four of the latter were resistant to mildew. These varieties were mostly intermediate in reaction to scald.

b. Varieties from Chosen.—This group of varieties appears to be an excellent source of resistance to mildew, and the three smut diseases. Seven varieties, CI 5173, CI 5176, CI 5178, CI 5180, CI 5185, CI 5187, and CI 5238, showed reasonably good resistance to all four of the diseases in theses tests. The winter survival of the varieties from Chosen was superior to the survival of the varieties from Russia and related areas; yet none of the seven disease resistant varieties listed above is as hardy as Missouri Early Beardless. Without exception varieties of this group are highly susceptible to scald and were completely defoliated by this disease when it was present.

Atkins and Dahms (2) pointed out the resistance to greenbugs in varieties of this origin. Seven varieties listed by them as resistant have been studied here. They are CI 5144, CI 5151, CI 5222, CI 5229, CI 5238, CI 5242, and CI 5255. Several of these, especially CI 5144 and CI 5238, are also resistant to mildew and at least two of the smut diseases.

c. Varieties from China and Manchuria.—Varieties from this area have shown varying degrees of hardiness and reaction to disease. CI 170 is very hardy and also resistant to scald. CI 5087 is resistant to mildew, *U. nigra* loose smut and covered smut. CI 5089 and CI 5091 are resistant to mildew and all three smut diseases.

Atkins and Dahms (2) reported resistance to greenbugs in CI 741, CI 2473, CI 5087, and CI 5092 of the varieties studied here.

d. Varieties from Europe.—None of the 11 varieties included in this group appears to be promising as a source of breeding material as far as the characters studied here are concerned.

e. Varieties of hybrid origin.—Several varieties from this group show good winter hardiness. The survival of Cusada CI 895, was equal to that of Reno and it was also resistant to scald.

A two-row variety, CI 898 Omar, was resistant to *U. nuda* loose smut.

f. Tennessee Winter types.—Like the Tennessee Winter types in Group 1, four of those in the world collection were found to be very hardy and also resistant to scald.

g. Miscellaneous.—From this miscellaneous group only one variety, CI 1412 from Persia, merits consideration and it for resistance to loose smut.

ADDITIONAL STUDIES NEEDED

It is recognized that varieties studied in this report can be classed as winter hardy or disease resistant only insofar as they have performed under the conditions described. Many factors may alter this performance, including environment, physiologic form of the disease organism, technique of disease inoculation and skill with which it was employed. The limitations of the conditions under which these results were obtained are fully recognized. But the information on the winter hardiness and disease resistance of winter barleys compiled herein should prove useful to barley breeders by pointing out the most promising sources of resistance.

Additional testing of these varieties is needed. It is hoped that varieties found to be resistant here will be extensively tested by other winter barley breeders in many locations and subjected to natural epidemics or inoculated with various collections of diseases. Only by that method can the best sources of breeding material be identified. No doubt some of these varieties will find their way into crosses. This will be the ultimate test of their usefulness.

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